



# NOvA Simulations

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# NOvA Simulations in a Nutshell



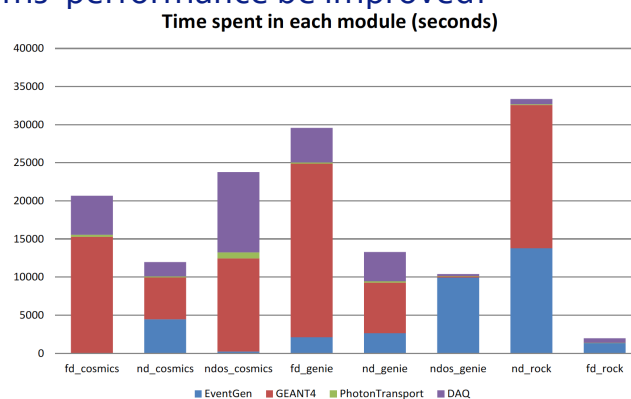
Simulation Step	Software Package	Output Product
Beamline	flugg (FLUKA+Geant4) also G4NuMI in future	Unified Beam Ntuple
	GENIE	gsimple.root
v Interactions (also cosmics, single particles)	ART Framework	art::Event (art::Run)
	GENIE or CRY/SingleParticle	+vector<MCTruth> vector<MCFlux>
	Geant4	+vector<FLSHitList> vector<ParticleList>
Detector Energy Depositions		
Rock, Cosmics Overlays	NOvASimMixer	Merge existing lists
Scint. Light Propagation	ImprovedPhotonTransport	+vector<PhotonSignal>
DAQ/Electronics	ReadoutSim	+vector<RawDigit> vector<RawTrigger>
Reconstruction/Analysis	Multiple User Packages	RecoHits, Prongs, Tracks,etc.

*Adapted from R. Hatcher, NOvA DocDB-6941*

# General Issues



- Need improvements to Geant4 validation tools
  - Geometry navigator difficult to use (*e.g.* in finding overlaps between beamline elements, or visualizing different components of the materials surrounding the detectors)
  - Would also like user-friendly tools for validation of physics lists
- Geant4 is main bottleneck in MC generation due to excess of information stored in simulation record
  - Also degrades performance for any packages downstream
  - It would be very useful to have a toolkit that allows removal of interactions that do not reach the detector volume, and setting depth of propagation for geometry volumes external to the detector
  - Can stepping algorithms' performance be improved?



# Beam Simulation Issues



- Beam simulations becoming more centralized (through NuMI-X consortium)
  - Dedication of larger amount of CD human resources to this effort would be welcome
- Support in packaging FLUKA and G<sub>4</sub>NuMI as UPS products
  - Currently, deployment of new versions of these products is cumbersome
  - This is necessary to be able to generate beam flux simulations using NOvA's large off-site computing resources (currently limited to NOvA cluster at Fermilab)

# Detector Simulation Issues



- Development of GENIE validation tools
  - Currently, do histogram comparisons using MC generated with new and previous versions
  - Easy to overlook problems, hard to explain any differences seen without getting feedback from GENIE authors
  - A past effort in computing flux\*cross-sections independently and comparing to GENIE output not being maintained
- Geant4 unable to decay tau and charm particles
  - For now, we hand these decays to GENIE, but this results in displaced vertices for the decayed products
  - Recipe to use G4VExtDecayer and Pythia6 exists, but not yet implemented